

Software Independent Verification and Validation (IV&V) Briefing for MIDEX Kickoff Meeting

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Software Independent Validation & Verification

What:

A system engineering process that evaluates the correctness and quality of a software product throughout its life cycle.

How:

By employing a variety of software engineering methods, techniques, and tools.

Who:

An organization that is technically, managerially, and financially independent of the development organization.

IV&V Benefits

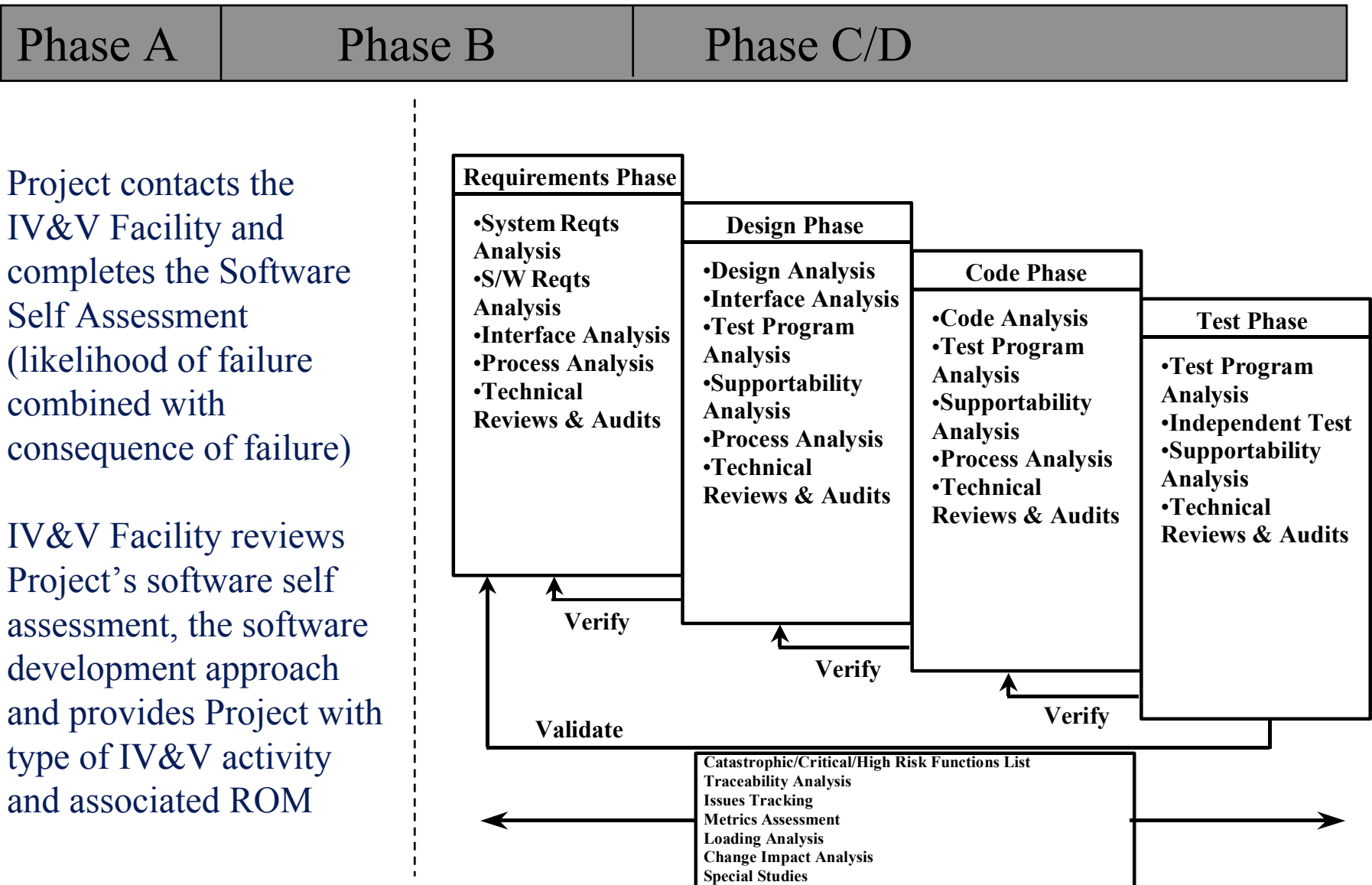
- Early identification of defects for resolution and containing software development costs.
- Increases safety and adds confidence
- Provides program management increased visibility into the software development process
- Identifies non-essential requirements
- Identifies risks associated with software
- Determines compliance between specification and performance
- Reduces latent defects and maintenance costs

NASA IV&V Policy (NPD 8730.4)

NASA will:

- Establish and apply a criterion, tools, and methodology to evaluate and assess software risk to identify appropriate level of IV&V
- Task the NASA IV&V Facility in Fairmont, WV, to manage the performance of all IV&V for software in Provide Aerospace Products and Capabilities (PAPAC) programs and projects identified per the above criterion and any other safety critical software (as defined in NASA-STD-8719.13A)
- Require PAPAC programs and projects to determine the level of IV&V to be performed with the explicit involvement of the IV&V Facility
- Require NASA programs and projects that contain mission or safety critical software to document decisions concerning the use of IV&V

Software Lifecycle with IV&V Phases and Analyses



Software Self Assessment Criteria

Factors contributing to Probability of Software Failure (Likelyhood)

- Software Team Complexity
- Contractor Support
- Organizational Complexity
- Schedule Pressure
- Process Maturity of Software Provider
- Degree of Innovation
- Level of Integration
- Requirement
- Software Lines of Code

Software Consequences of Failure Rating

- **Grave** (e.g. potential for loss of life, equip loss > \$100M, international adverse visibility)
- **Substantial** (e.g. potential for serious injury, equip loss > \$20M, national adverse visibility)
- **Marginal** (e.g. agency-level adverse visibility)
- **Insignificant**

Software IV&V Self-Assessment Results

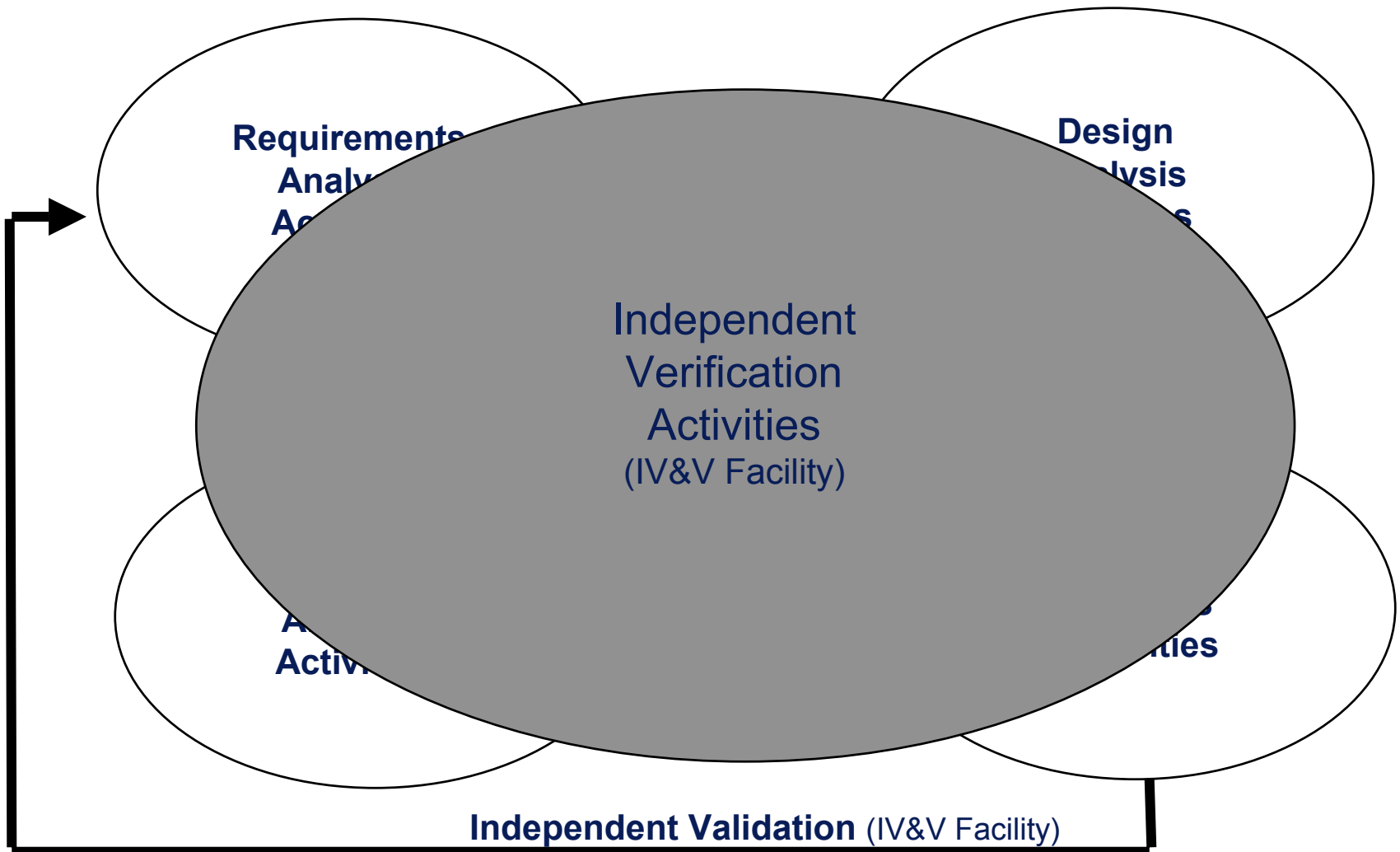
SOFTWARE RISK					
Consequence of Software Failures	GRAVE	IA	IV&V	IV&V	IV&V
	SUBSTANTIAL		IA	IV&V	IV&V
	MARGINAL				IA IV&V
	INSIGNIFICANT				
Likelihood of Failures					

IV&V Facility Independent Processes

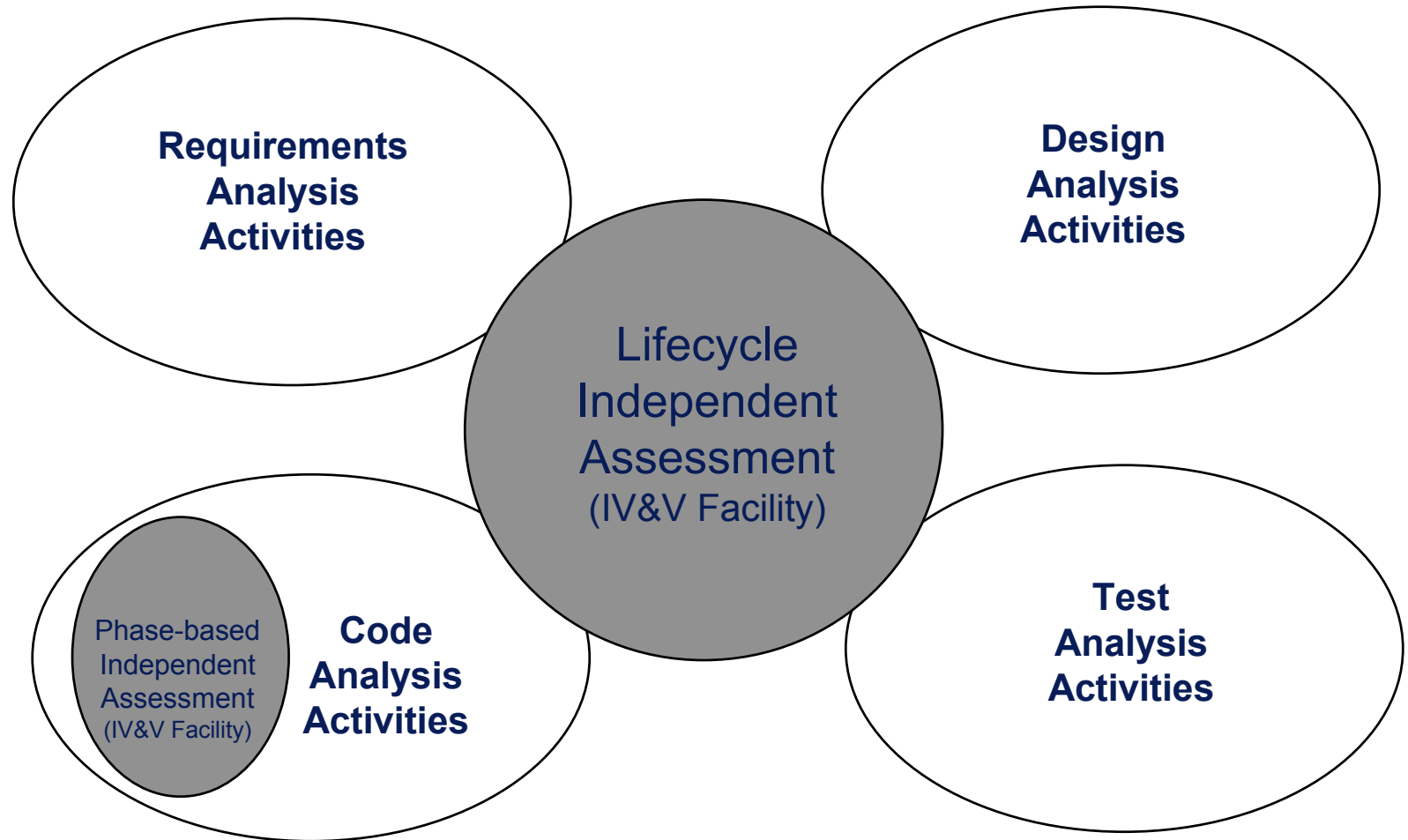
- Independent Verification and Validation (IV&V)
- Independent Assessment (IA)

Independent Verification and Validation (IV&V)

Independent Verification



Independent Assessment (IA)



Characteristics: Typically low risk, mature software developer, no significant organizational complexity, small team, low code count and low to medium consequence of failure.

Example

(IV&V Activities for the Requirements Phase)

Activity	B	L	F	C
Verify documentation meets intended purpose, has appropriate detail and all necessary elements	X	X	X	X
Validate ability of requirements to meet system needs	X	X	X	X
Verify Traceability to and from parent requirements	X	X	X	X
Analyze data/adaptation requirement	X	X	X	X
Analyze Testability, Qualification requirements	X	X	X	X
Analyze Data Flow, Control Flow, moding and sequencing	X	X	X	X
Assess development metrics	X	X	X	X
Analyze development risks/mitigation plans	X	X	X	X
Analyze Timing and Sizing requirements	X	X	X	X
Review developer timing/sizing, loading engineering analysis			X	X
Perform engineering analysis of key algorithms			X	X
Review/use developer prototypes or dynamic models			X	X
Develop alternative static representations (diagrams, tables)			X	X
Develop prototypes or models				X
Perform timing/sizing/loading analysis				X
Apply formal methods				X

B – Basic
 L – Limited
 F – Focused
 C – Comprehensive

IV&V Process Overview

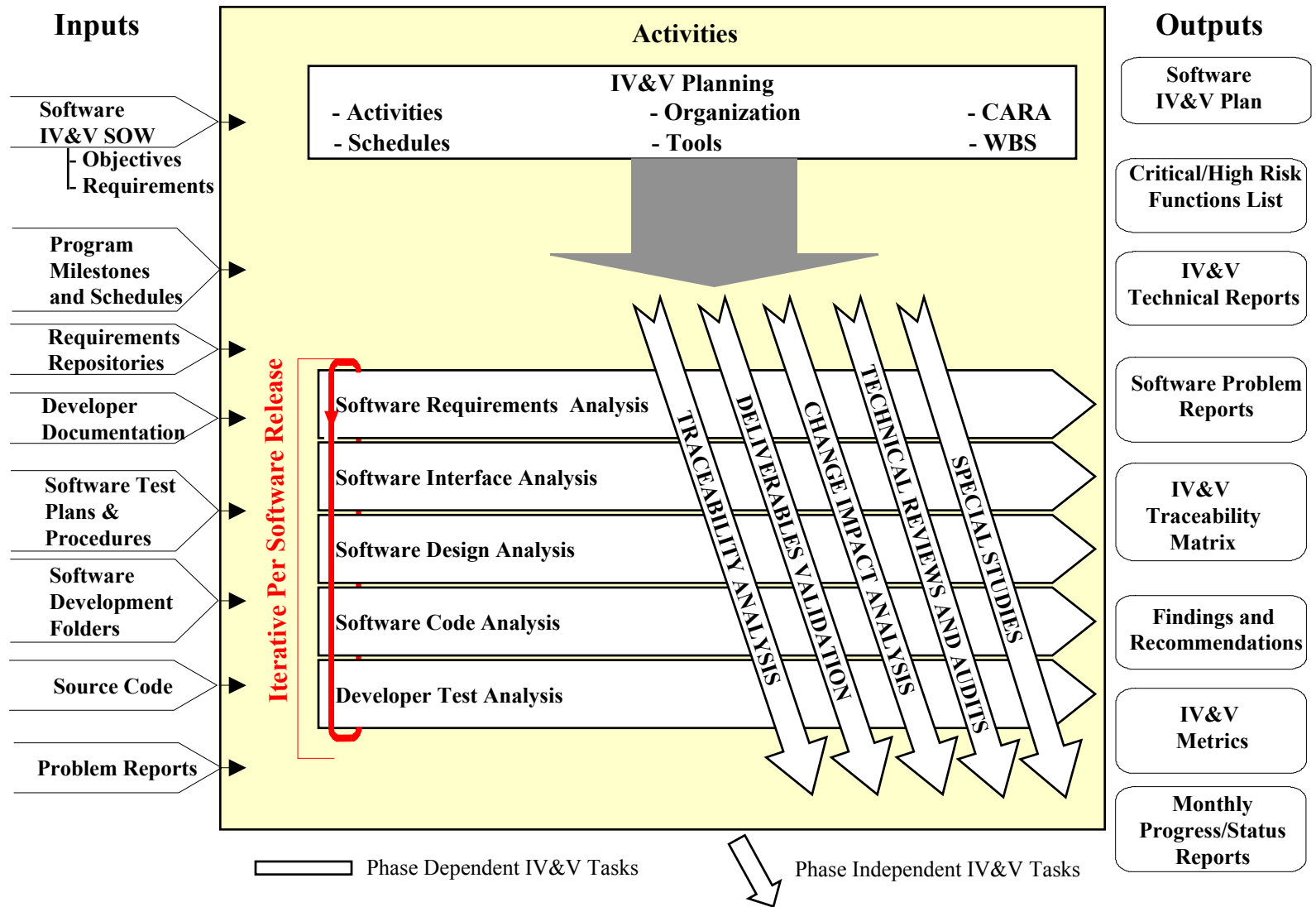
- **Mission Project Manager evaluates their project against NASA IV&V Criteria (web-based)**
 - Contact John Marinaro (john.marinaro@ivv.nasa.gov) with a point of contact (email address, project name, location, etc.)
- **The NASA IV&V Facility will review the results and type of service recommended (IV&V, IA, None)**
 - IV&V Facility evaluates results to ensure proper interpretation of the criteria
 - Sometimes additional information is required, such as mission goals, proposed organization, instrument information, and software architecture, etc. (if available)
- **The IV&V Facility contacts the project to discuss the results and reach mutual agreement**
- **Once agreement is reached the IV&V Facility can provide a rough cost estimate**
 - Based on general guidelines used during proposal process
 - May be refined based on results of self-assessment
 - Official IV&V cost ROM will be provided for the mission (in writing) from the IV&V Facility

Conclusion

- Our primary goal is to get as much software development specific information, as early as possible, in order to scope the project appropriately.
- We will review the mission with project management again after down-select by verifying the self assessment data and discussing any concept of operation modifications.
- Early involvement would include IV&V systems engineering support and preliminary requirements analysis (prior to SRR).
- Goal is to begin IV&V ramp-up activities following System Requirements Review. IV&V uses a phased staffing approach that ramps up late in Phase B at the beginning of the project's software development effort and ramps down with the completion of integration and test activities prior to launch for missions that have a short time to orbit. IV&V will be complete at IOC.
- For those missions that have a long interplanetary cruise periods and continued software development, IV&V will continue to support the software development efforts.

Backup Charts

Iterative IV&V Methods Promote Efficiency



Criticality Analysis and Risk Assessment

In order to prioritize the IV&V activities, each software component/function is reviewed from a criticality and risk perspective:

- Criticality aspects
 - Performance and Operations
 - Safety
 - Cost/Schedule
- Risk aspects
 - Complexity
 - Technology Maturity
 - Requirements Definition & Stability
 - Testability